

# TECHNOLOGY ACTION PLAN ADAPTATION GRENADA

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## CHAPTER 1 TECHNOLOGY ACTION PLAN AND PROJECT IDEAS FOR AGRICULTURE SUB-SECTOR

### 1.1 Sub-Sector Overview

Agriculture's contribution to total real GDP increased from 4.6% in 2010 to 5.5% in 2014. Low resource farmers on small farms averaging 2.54 acres dominate agricultural activities in Grenada. The average food crop farm is 0.27 acres and 13 percent of the agricultural acreage is cultivated with fruits vegetables and root crops. The crop sub-sector is the major contributor to agriculture GDP during the accounting period, accounting for 2.8% of total GDP.

Vegetables are the second largest category of fresh produce marketed locally, about 20 product lines are currently purchased and sold locally and 10 imported. As for fruits, the greatest threat is water scarcity. Vegetables are produced by a large number of small farmers on plots averaging less than 0.25 acres. The acreage under production is 600 acres according to the Grenada Agricultural Census 2012.

Inadequate irrigation is considered as one of the major factors constraining agricultural productivity and food production resulting in the seasonality of agricultural crops.

#### **Document highlighting vulnerability of agriculture sector**

Name of legislation/regulation policy	Date enacted or revised	Main contents	Comments
Food and Nutrition Security Policy	2013	Stability of rain-fed food production system, which is affected by, prolonged droughts resulting in seasonal food insecurity. It confirms the limited access to credit from private financial institutions because agriculture is viewed as high risk due to inconsistent weather patterns. Increased use of irrigation and Rain Water Harvesting are among the strategic areas.	

### 1.1.1 Description of Micro-Dam Technology

A micro dam is a small reservoir, which can be lined with clay or concrete and used for storage of water for agricultural irrigation. It was selected to provide an alternate source of water for farmers who have to rely on rainfall to grow vegetables. Runoff is captured and stored in the dam, which could also help to reduce flooding. It could be constructed on a hillside as well as on flat terrain.

As the rainfall becomes more erratic the demand for irrigation has been growing. A micro dam provides a reliable access to irrigation water and acts as a buffer to the variability of the rainfall regime and increases resilience against dry spells during the rainy season, as well during the dry season.

A micro dam can help farmers to adapt to water shortages brought about by climate variability and change by providing them with a reliable supply of water. It has the potential to allow farmers to grow a wider variety of vegetables especially during dry season providing farmers with an increase in income and increased food security.

While initial cost of constructing a micro dam is high especially if it is lined with concrete there are several benefits. They include a reduction in the use of potable water for non-potable purposes, reduced river abstraction resulting in the maintenance of the ecological flows in rivers especially during the dry season and improvement in the livelihood of farmers.

### 1.1.2 Ambition for the Technology Action Plan for Micro-Dam

According to the Water Deficit Map the north and south extremes of the island receives the least amount of rainfall and generally rely on irrigation to grow fruits and vegetables in the dry season but more recently irrigation is required almost year-round in order to grow fruits and vegetables. The target is to establish an agriculture rainwater-harvesting programme for the eastern side of Grenada, including a demonstration project, and to develop a cadre of local persons trained and certified in the design and construction of the micro dam.

### 1.1.3 Actions and Activities Selected for Inclusion in the Technology Action Plan for Micro- Dam

The actions and activities for inclusion were selected from the measures identified to overcome the barriers to the diffusion of the technology. The barriers were identified using the Problem Tree methodology, while the measures were identified using the Solution Tree methodology. The actions and activities were prioritized for inclusion in the TAP.

#### Summary of barriers and measures to overcome barriers

Micro Dam		
Categories	Identified Barriers	Measures
Economic and financial	Limited investment Lack of access to financial capital	Credit scheme (loan/grant) for construction of micro dam
Market Conditions		
Legal and regulatory		
Network structures		
Institutional and organizational capacity	Rainwater harvesting for agriculture irrigation not included in National Water Policy Agricultural Policy does include rainwater harvesting for agriculture irrigation	Revision of the National Water Policy to include rainwater harvesting for agricultural irrigation
Human skills	Limited technical capacity	Capacity building
Social and cultural behavior	Traditional practice of rain fed agriculture	Create awareness of projected changes in rainfall pattern
Information and awareness	Lack of awareness of projected changes in rainfall pattern	Create awareness of projected changes in rainfall pattern
Technical		
Other	No demonstration project	Demonstration project

### **Actions selected for inclusion in the TAP**

Categories	Identified measures to overcome barriers	Measures selected as Actions for the TAP
Economic and Financial	Create access to loan/grant credit scheme	Create credit scheme (loan/grant) for construction of micro dam
Market conditions		
Legal and regulatory		
Network structures		
Institutional and organisational	Revision of the National Water Policy to include rainwater harvesting for agricultural irrigation	
Human skills	Capacity building	Capacity building
Social, cultural and behavioural	Create awareness of projected changes in rainfall pattern	
Information and awareness	Create awareness of projected changes in rainfall pattern	
Technical		
Other	Create demonstration project	Create demonstration project

**Activities identified for implementation as selected actions**

<b>Action#1</b>	Demonstration project
<b>Action# 2</b>	Capacity building
<b>ACTIVITIES:</b>	<b>Action1: Demonstration project</b>
<b>Activity 1.1</b>	Review of potential sites for the location of micro dam
<b>Activity 1.2</b>	Selection of site for demonstration project
<b>Activity 1.3</b>	Procurement of consultancy services
<b>Activity 1.4</b>	Collect data for design of micro dam
<b>Activity 1.5</b>	Design and costing of micro dam
<b>Activity 1.6</b>	Procurement of goods and services for construction of micro dam
<b>Activity 1.7</b>	Construction of the micro dam
<b>Activity 1.8</b>	Development of operations, management and maintenance plan for micro dam
	<b>Action 2 Capacity Building</b>
<b>Activity 2.1</b>	Procurement of consultancy services for training
<b>Activity 2.2</b>	Sensitization session on micro dam
<b>Activity 2.3</b>	Conduct training course in the design and construction of the micro dam
<b>Activity 2.4</b>	Development of a data collection programme to monitor and evaluate the benefits of rainwater harvesting. Data collection should include the impact of rainwater harvesting on stream flow.

#### 1.1.4 Actions to be implemented as Project Ideas

Two actions would be implemented, as projects ideas. They are the demonstration project and capacity building. The demonstration project was selected because there is no demonstration project existing where farmers could be exposed to the technology and experience the benefits. Capacity building was selected because there is no institution offering the service to construct micro dams locally and farmers have been experimenting with the technology on their own. Capacity building is necessary if the agriculture rainwater-harvesting programme is to be successfully implemented.

##### Demonstration project

The demonstration project was selected because it was one of the recommendations of the feasibility of Rainwater Harvesting for Grenada. The storage of rainwater in micro dams is the only option for farmers whose farms are not located near rivers/streams and who do not have access to potable water from the National Water and Sewerage Authority. Farmers can no longer rely on rain-fed agriculture especially those cultivating fruits and vegetables. Farmers are advised to irrigate their crops, but availability of water for irrigation is a problem because the Ministry of Agriculture is discouraging the use of potable water, which is widely used for irrigation.

The construction of a micro-dam is expensive and farmers would have to be convinced of the benefits of the investment and therefore the best way to convince them is through a demonstration project. The micro dam would increase the availability of stored water in the dry season and retain water in the rainy season thereby reducing the risk of flooding.

##### Capacity building

The national and regional studies recommended the implementation of a national programme for rainwater harvesting for agricultural irrigation.

Studies on rainwater harvesting at the national and regional levels have also recommended capacity building for the extension staff of the ministry of agriculture and farmers. However, local stakeholders were of the view that professionals in the private sector should also be trained and certified to provide that service to farmers. While rainwater harvesting is not new to Grenada the quality of dam construction has been a major concern.

### 1.1.5 Stakeholders and Time Line for Implementation of TAP

#### Overview of Stakeholders for the implementation of the TAP

Farmers are expected to be the main beneficiaries of the implementation of the action plan. They were among the stakeholders involved in the Technology Needs Assessment process. Their continued involvement in the planning process is critical because they have an interest in the TAP since they are one of the main beneficiaries and they can influence the outcome of the project. From the discussions and the review of the studies done locally, farmers expressed the need for micro dams but they had reservations about the effectiveness of the technology.

The staff of the Irrigation Management Unit (IMU) also has interest in the TAP because they would also be one of the main beneficiaries of the capacity building measures and can influence the outcome of the TAP. The IMU would be the department directly responsible for the implementation of the TAP.

Another important stakeholder is the Economic and Technical Cooperation, which is the National Designated Authority for the Green Climate Fund. The G-CREWS project includes a Challenge Fund under which farmers can access funds.

The Extension Department, of the Ministry of Agriculture would be expected to play a supporting role and to provide the day-to-day liaison with the farmers. The extension officers can therefore influence the outcome of the project.

The key stakeholders recommended that the training be conducted under the National Training Agency, which will award the certification. The training would be open farmers, staff of the Ministry of Agriculture and professionals from the private sector.

The Caribbean Agricultural Research Organisation (CARDI) is a stakeholder because the organisation constructed a micro dam in Grenada in the 1970's, which is still in operation and could provide technical assistance to the project.

#### Scheduling and sequencing of specific activities

The construction of a demonstration micro dam is expected to be part of the practical application of the knowledge provided during the training session. Therefore theoretical component of the training must precede the construction of the dam. The practical component of the training will be done at the same time with the construction of the demonstration micro-dam.

Prior to the start of the Training, there are several activities, which must be done. Contact has to be made with the National Training Agency to get approval for the certification of the course. Engagement of a consultant to conduct the course and approval has to be completed before the course could start. The selection of the site for the demonstration project must also be completed before the training could start.

Before the site is selected a discussion has to be held with the prospective host farmer and agreement reached on the conditions for hosting demonstration site. All these activities are to

be done at the same time. Work on the establishment of the credit scheme could also start at the same time although the, training course and construction of the demonstration micro dam must be completed before the credit scheme comes into operation. The island-wide programme for agriculture rainwater harvesting would be a long-term activity lasting up to five years.

### Scheduling and sequencing of specific activities

Action	Activities:	Planning		Implementation		Responsibility	
		Starting date	Ending date	Starting date	Ending date	Primary	Secondary
Construction of the demonstration micro dam	Review of potential sites for the location of micro dam					Chief Agricultural Officer	Department Economic and Technical Cooperation
	Selection of site for demonstration project					Chief Agricultural Officer	Department Economic and Technical Cooperation
	Procurement of consultancy services	9/2018				Chief Agricultural Officer	Department Economic and Technical Cooperation
	Collect data for design of micro dam					Chief Agricultural Officer	Department Economic and Technical Cooperation
	Design and costing of micro dam					Chief Agricultural Officer	Department Economic and Technical Cooperation
	Procurement of goods and services for construction of micro dam					Chief Agricultural Officer	Department Economic and Technical Cooperation
	Construction of the micro dam					Chief Agricultural Officer	Department Economic and Technical Cooperation
	Development of operations, management and maintenance plan for micro dam					Chief Agricultural Officer	Department Economic and Technical Cooperation
	Procurement of consultancy services for training					Chief Agricultural Officer	Department Economic and Technical Cooperation
	Sensitization session on micro dam					Chief Agricultural Officer	Department Economic and Technical Cooperation
	Conduct training course in the design and construction of the micro dam					Chief Agricultural Officer	Department Economic and Technical Cooperation
Capacity building	Development of a data					Chief Agricultural	Department Economic and

	<p>collection programme to monitor and evaluate the benefits of rainwater harvesting. Data collection should include the impact of rainwater harvesting on stream flow.</p>					Officer	Technical Cooperation
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### 1.1.7 Resources Needed for Action and Activities

Capacity required for implementation of activities

**Financial planning** skills are required to design the loan/grant credit scheme

**Project management** skills are required to implement the activities for the project concept including preparation of contracts and procurement of material and hiring of equipment for the construction of the micro dam, for preparation of contracts for consultancy services to conduct the training course in micro dam construction.

**Financing:** skills are required to identify the funding sources, which the project concept could be aligned with, and the coordinate with the relevant institutions to secure the funding

**Engineering:** skills are required for the design of the micro dam technology as a demonstration project

**Technology deployment:** skills are required for the construction of the micro dam

Estimated costs for implementing activities

Activities incurring costs include:

- Meetings
- Procurement of material for construction of micro dam and hiring of equipment
- Consultants to conduct training in the design and construction of micro dam
- Local travel costs for participants
- Venue for training course
- Course materials

## 1.1.8 Management Planning

### Risks and Contingency Planning

<b>Risk item</b>	<b>Description</b>	<b>Level of Risk</b>	<b>Mitigation/Contingency Action</b>
Cost	Refund for course participants transportation costs may become necessary and lead to unexpected cost increase	High	Include contingency line item in budget to cater unexpected increase in transportation cost
Scheduling	The construction of the micro dam could take longer than expected due to delays caused by weather	Medium	Schedule activities during dry season
Political interference	Selection process of farmer to host demonstration project may face political interference and lead to delay in completion of selection process	Medium	The process and conditions for selecting the farm would be made public and transparent
Performance	The micro irrigation does not perform as expected and deter other farmers from investing in the technology	Low	Ensure the performance risk is the responsibility of the contractor and is tied to payment

### 1.1.9 Next Steps

Immediate Requirements:	Designate a coordinator for the project to engage the National Training Agency to get approval for the certification for the course. To follow up on the identification of an instructor for the training course on the construction of the micro dam, identify participants for the course, identify and select host farmer for the demonstration project
Critical Steps:	Engagement with the Ministry of Agriculture to take responsibility for the implementation of the project

### 1.1.10 TAP Overview Table for Micro-Dam Technology

Sector	Water							
Subsector	Agriculture							
Technology	Micro Dam							
Ambition	To construct micro-dams along the eastern side of Grenada as a source of irrigation water for vegetable and fruit production year round							
Benefits	<p>Year round vegetable and fruit production</p> <p>Increase in farmers income</p> <p>Improvement in farmers livelihood</p> <p>Reduction in risk of flooding</p> <p>Increase in water availability during dry season</p> <p>Increase in food security</p> <p>Create employment for trained cadre of persons</p>							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for monitoring of implementation	Budget per activity
Action 1 Construction of demonstration micro dam	Activity 1.1 Selection of site for micro dam	Government of Grenada/	Irrigation Management Unit	3 months	Farmers are unavailable	Site selection completed	Reports on site visits	0
	Activity 1.2 Procurement of consultancy services	Climate change	Ministry of Agriculture	3 months	Delay due to administrative procedures	Consultant hired	Consultant reports	
	Activity 1.3 Design and costing of micro dam	Climate Change funds	Irrigation Management Unit	3 months	Delays in data requested	Design and costing completed	Designs for micro dam available	
	Activity 1.4 Procurement of goods for construction of micro dam	Climate Change funds	Ministry of Agriculture	3 months	Implementation delays	Receipt of goods	Work on dam construction	
	Activity 1.5 Construction of micro dam	Climate Change funds	Irrigation Management Unit	One month	Delays due to extreme weather events	Completed micro dam	Micro dam operational	
	Activity 1.6 Development of operations, management and maintenance plan	Climate Change funds	Irrigation Management Unit	3 months	Delays in the review of draft document	Final draft of plans	Approved plans	
Action 2 Conduct training	Activity 2.1 Procurement of	Government of Grenada	Ministry of Agriculture	3 months	Delays due to administrative	Consultant awarded contract	Consultant taking up duty	0

programme in micro dam construction	consultancy services				procedures			
	Activity 2.2 Sensitization session on micro dam	Climate Change funds	Irrigation Management Unit	1 month	Difficulty scheduling due to competing activities	Session conducted	Report on session	
	Activity 2.3 Conduct training course in the design and construction of the micro dam	Climate Change funds	Irrigation Management Unit/ National Training Agency	6 months	Disruption due to severe weather  Participants inability to commit due to planting season	Training conducted	Report on training course	
	Activity 2.5 Development of a data collection programme	Climate Change funds	Irrigation Management Unit	1 month	Lack of capacity to support programme development	Programme developed	Completed programme for data collection	

## 1.2. Micro-Irrigation Technology Description

Micro-irrigation technology refers to technology, which employ water emitters with tiny apertures that deliver water at a low flow rate. It used to keep the demand for water to a minimum.

It comprises drip irrigation and micro spray technology and is one of the pressurized irrigation technologies and water pressure dissipation is kept to a minimum. Micro-irrigation technology is subdivided into two groups based on water emitting patterns. In one group the water is applied directly to the soil in discrete drops by drippers or as a continuous stream by bubblers. The other sub-group the water is conveyed through the air and applied to the soil as a spray, mist or multiple discrete jets.

The pipes for the water delivery and distribution for the micro irrigation system can either be PVC or polyethylene. Ordinary PVC pipes do not have UV protection and should be installed underground; UPVC pipes have more endurance than PVC. Polyethylene lines can be installed above or underground.

Although the initial investment costs are high, it was selected because it is a water-efficient technology and developed for use in water scarce areas. Studies conducted in India for example notes that the technology has the deliver benefits such as increased yield, improvement in water use efficiency and the reduction in water use and costs.

The reduction in water use is beneficial to the environment especially the rivers which would be able to maintain environmental flows. Micro-irrigation technology is useful as an adaptation measure as Grenada prepares to cope with the projections of a drier climate.

Micro-irrigation would allow farmers, especially vegetable farmers to grow their crops all year round instead of only in the rainy season which result in an increase in income for farmers and food security for the country. The use of water-efficient technologies reduces the pressure on surface water, which is the main source of water for Grenada.

### 1.2.1 Ambition for the TAP

The target is to build the capacity of a cadre of local persons in order to meet the demand for technical assistance in the installation of micro-irrigation technology island wide and to install a demonstration project.

## 1.2.2 Actions and Activities selected for inclusion in the TAP

The actions and activities for inclusion were selected from the measures identified to overcome the barriers to the diffusion of the technology. The barriers were identified using the Problem Tree methodology, while the measures were identified using the Solution Tree methodology. The actions and activities were prioritized for inclusion in the TAP.

### Summary of barriers and measures to overcome barriers

Micro irrigation		
Categories	Identified Barriers	Measures
Economic and financial	The high initial cost of the technology Lack of access to credit	Create loan/grant credit scheme
Market Conditions	Small size of market	
Legal and regulatory		
Network structures		
Institutional and organizational capacity		
Human skills	Limited capacity of the Irrigation Management Unit	Capacity building
Social and cultural behavior	Traditional practice of rain fed agriculture	Sensitization on projected changing rainfall pattern
Information and awareness	Lack of awareness of technology	Conduct sensitization session on technology
Technical		
Other	Lack of demonstration project Small size of farm	Demonstration project

**Actions identified for inclusion in the TAP**

Categories	Identified measures to overcome barriers	Measures selected as Actions for the TAP
Economic and Financial	Create loan/grant credit scheme	Create loan/grant credit scheme for
Market conditions		
Legal and regulatory		
Network structures		
Institutional and organisational		
Human skills	Capacity building	Capacity building
Social, cultural and behavioural	Sensitization on projected changing rainfall pattern	
Information and awareness	Conduct sensitization session on technology	Conduct sensitization session on technology
Technical		
Other	Create demonstration project	Create demonstration project

### Activities identified for implementation as selected actions

<b>Action# 1</b>	<b>Demonstration project</b>
<b>Action# 2</b>	<b>Capacity building</b>
<b>ACTIVITIES:</b>	<b>Action 1: Demonstration project</b>
<b>Activity 1.1</b>	Selection of a site for demonstration project
<b>Activity 1.2</b>	Procurement of consultant
<b>Activity 1.3</b>	Design of irrigation system
<b>Activity 1.4</b>	Procurement of drip and micro spray irrigation equipment and pump
<b>Activity 1.5</b>	Installation of equipment including flow meters
	<b>Action 2: Capacity building</b>
<b>Activity 2.1</b>	Training in the design of irrigation systems including the appropriate pump
<b>Activity 2.2</b>	Hands on training in the installation of the irrigation equipment
<b>Activity 2.3</b>	Training in reading and making records of flow meter
<b>Activity 2.4</b>	Design of a system to collect data and monitor water use

### 1.2.3 Actions to be Implemented as Project Ideas

Studies on irrigation in Grenada have recommended the installation of a demonstration project. The Irrigation Management Unit has been providing support to farmers to design and install micro irrigation systems the unit does not have a demonstration site for teaching farmers. The Irrigation Management Unit is currently unable to use a demonstration project to convince farmers of the advantages and benefits of using micro irrigation technologies.

The Irrigation Management Unit is the only institution with the capacity to design, install and maintain agriculture irrigation systems but it is currently understaffed. Farmers have expressed the desire to build their capacity. The Irrigation Management Unit has indicated that there is a need for four additional staff but the government of Grenada has an attrition policy in effect, which restricts the hiring of new staff. The proposal is to build a cadre of local persons would be certified in providing the service. The key stakeholders, therefore, proposed that the training be open to farmers, and local professionals in the private sector including companies selling irrigation equipment. The inclusion of the private sector in the training would allow them to provide technical assistance to farmers purchasing the technology and to provide after-sale service, which is currently unavailable.

## 1.2.4 Stakeholders and Timeline for Implementation of TAP

### Overview of Stakeholders for the implementation of the TAP

The primary stakeholder for the conduct of the training course is the National Training Agency. The National Training Agency was proposed because it would allow for the certification of participants. Therefore the National Training Agency could influence the success of the training programme.

The vegetable and fruit farmers are another primary stakeholder group. They are the main beneficiaries and they have to be kept involved throughout the project life.

Participants in the training course are also a primary stakeholder group. They can influence whether the course is successful and whether the capacity building activities are sustainable.

The ministry of agriculture is an important stakeholder since they would influence the selection of the participants for the training course as well as the site for the demonstration project.

The Economic and Technical Cooperation Department of the Ministry of Finance is a key stakeholder since they have the mandate for mobilizing resources for projects.

### Scheduling and sequencing

The engagement of the National Training Agency would be the first step. This is to be followed by the engagement of the consultant, the setting of the criteria for selection and then the recruitment of participants for the training course.

The selection of the site for the demonstration project would be done at the same time with the selection of the participants for the training course. Prior to the selection of the site, the host farmer has to agree to the terms and condition for hosting the site. The theoretical component of the course must be done before the demonstration project could start. The practical component and the demonstration project would be done at the same time.

A management and maintenance plan for the demonstration site would be developed after the site is selected. The installation of micro-irrigation technology island-wide would last up to five years.

### Scheduling and sequencing of specific activities

Action	Activities:	Planning		Implementation		Responsibility	
		Starting date	Ending date	Starting date	Ending date	Primary	Secondary
Installation of micro irrigation technology	Selection of a site for demonstration project					Chief Agricultural Officer	Department Economic Technical Cooperation
	Procurement of consultant	9/2018				Chief Agricultural Officer	Department Economic Technical Cooperation
	Design of irrigation system					Chief Agricultural Officer	Department Economic Technical Cooperation
	Procurement of drip and micro spray irrigation equipment and pump					Chief Agricultural Officer	Department Economic Technical Cooperation
	Installation of equipment including flow meters					Chief Agricultural Officer	Department Economic Technical Cooperation
Capacity building	Training in the design of irrigation systems including the appropriate pump					Chief Agricultural Officer	Department Economic Technical Cooperation
	Hands on training in the installation of the irrigation equipment					Chief Agricultural Officer	Department Economic Technical Cooperation
	Training in reading and making records of flow meter					Chief Agricultural Officer	Department Economic Technical Cooperation
	Design of a system to collect data and monitor water use					Chief Agricultural Officer	Department Economic Technical Cooperation

### 1.2.5 Resources Needed for Action and Activities

Capacity requirements for implementation of activities are:

**Financial planning** skills are required to design the loan/grant credit scheme

**Project management** skills are required to implement the activities for the project concept including preparation of contracts for consultancy services to conduct the training course in Small Scale Irrigation and procurement of irrigation equipment and pump

**Financing:** skills are required to identify the funding source, which the project concept could be aligned with, and the coordinate with the relevant institutions to secure the funding

**Engineering:** skills are required for the design of the micro irrigation technology demonstration and the sizing of irrigation pump

**Technology deployment:** skills are required for the installation of the drip and micro spray irrigation equipment

Estimations of costs of actions and activities

- Activities incurring costs include:
  - Meetings
  - Procurement of micro irrigation equipment
  - Consultants to conduct training in Small Scale Irrigation and installation of irrigation equipment
  - Local travel costs for participants
  - Venue
- Course materials

### 1.2.6 Management Planning

A project steering committee would be established to provide strategic advice to the project; to regularly assess the project health, and to ensure the project is on track and the objectives are being met.

A project coordinator would be employed to manage the project and to ensure the delivery of the project with scope, budget, and schedule.

#### Risks and Contingency Planning

<b>Risk item</b>	<b>Description</b>	<b>Level of Risk</b>	<b>Mitigation/Contingency Action</b>
Cost	Refund for course participants transportation costs may become necessary and lead to unexpected cost increase	High	Include contingency line item in budget to cater unexpected increase in transportation cost
Scheduling	The installation of the equipment could take longer than expected due to delays caused by weather	Medium	Schedule activities during dry season
Political interference	Selection process of farmer to host demonstration project may face political interference and lead to delay in completion of selection process	Medium	The process and conditions for selecting the farm would be made public and transparent
Performance	The micro irrigation does not perform as expected and deter other farmers from investing in the technology	Low	Ensure the performance risk is the responsibility of the contractor and is tied to payment

### 1.2.7 Next Steps

Immediate Requirements:	Designate a coordinator for the project to engage the National Training Agency to get approval for the certification for the course. To follow up the procurement of the instructor for the training course, identify participants for the Small Scale Irrigation course, identify and select host farmer for the demonstration project
Critical Steps:	Engagement with the ministry of Agriculture to take responsibility for the implementation of the project

### 1.2.8 TAP Overview Table for Micro Irrigation Technology

Sector	Water							
Subsector	Agriculture							
Technology	Micro Irrigation Technology							
Ambition	To have vegetable and fruit farmers island wide equipped with micro irrigation technology							
Benefits	Year round vegetable and fruit production Increase in farmers income Improvement in food security Water saving from use of more efficient technology Create employment for cadre of trained persons							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for monitoring of implementation	Budget per activity
Action 1 Conduct training programme	Activity 1.1 Selection of site for demonstration project	Government of Grenada	Irrigation Management Unit	3 moths	Delays due to severe weather	Site selected	Start of installation of irrigation equipment	0
	Activity 1.2 Hiring of consultant	Climate Change funds	Ministry of Agriculture	3 months	Implementation Delays	Contract awarded	Consultant taking up duties	
	Activity 1.3 Conduct training course	Climate Change funds	Irrigation Management Unit	1 week	Difficulty scheduling training	Training course conducted	Report on training course	
	Activity 1.4 Design of demo irrigation system	Climate Change Funds	Irrigation Management Unit	3 months		Design for demo completed	Drawings for demo irrigation centre	
Action 2 Installation of micro-irrigation technology demonstration project	Activity 2.1 Procurement of drip and micro spray irrigation equipment	Climate Change funds	Irrigation Management Unit	1 month	Delay in receipt of equipment	Procurement documents available	Equipment receipt	
	Hands on training in the installation of the irrigation equipment	Government of Grenada	Irrigation Management Unit	1 week	Late arrival of equipment	Installation of equipment commences	Installation of equipment completed	0
	Training in reading and keeping records	Climate Change funds	Irrigation Management Unit	3 months		No of participants in attendance	Participants lists	
	Design of a system to collect data and monitor water use	Climate Change funds	Irrigation Management Unit	3 moths		Data system operational	Reports generated	

## 1.3 PROJECT IDEAS FOR AGRICULTURE SUB SECTOR

### 1.3.1 Brief Summary of the Project Ideas for Agriculture Sector

The over all project idea is to introduce agriculture irrigation water to Grenada and to increase the use of water-efficient technologies for agriculture irrigation. The building of the capacity and the institutional arrangements to support the expansion in the use of micro-dams and micro irrigation technologies is another project idea.

The specific ideas include:

- Agro-meteorological data collection
- Water quality monitoring
- Establishment of water users groups
- Water users fees
- Study on the demand for irrigation (water and infrastructure)
- Credit scheme

### 1.3.2 Specific Project Ideas for Agriculture

Small farmers practicing mostly rain fed agriculture dominate the agriculture sector. Only a limited number of vegetable and fruit farmers are practicing agriculture irrigation and a smaller number is harvesting rainwater for farm-scale irrigation. Farmers are already feeling the impact of the changing rainfall pattern and can no longer rely on rain fed agriculture to grow fruits and vegetables. For those vegetable and fruit farmers already practicing irrigation, there is a challenge accessing water in the dry season because agriculture irrigation water is no public irrigation water supply system and only a few private farm-scale irrigation water supply schemes.

Currently, there is no private sector company providing technical assistance in irrigation and only the Irrigation Management Unit has the capacity to provide that assistance and that unit is grossly understaffed. To date, none of the projects providing support for irrigation has included a capacity building component.

#### Objectives

The objective is to increase the adoption of micro-dams and micro-irrigation technologies and to build capacity in the use of the technology.

#### Outputs

The outputs from the project would be a cadre of trained persons with the capacity to design and construct micro-dams and to design and install micro-irrigation technologies.

- Micro-dam and irrigation infrastructure
- Institutional support for agriculture irrigation

#### Relationship with sustainable development priorities

The project is consistent with the Sustainable Development Goals (SDG6), the National Adaptation Plan 2017-2021 water availability and food security priority areas and the National Climate Change Policy 2017-2021 objectives and policy framework.

#### Deliverables Value/Benefits/Messages

The main deliverables are as follows:

- Two demonstration projects,
- A credit scheme to provide an incentive programme for farmers to adopt the micro-dam and micro-irrigation technologies
- A cadre of trained persons who could design and construct micro dams and design and install micro-irrigation technologies.
- Institutional framework to support irrigation

The project is seeking to adopt a participatory approach with the training of training of farmers in the design and construction of a micro dam and the design and installation of the micro irrigation technologies. This is intend to break with the past belief that farmers are unable to understand technical matters and therefore cannot make a contribution to technical matters.

Farmers would therefore been involved in the planning process from the conception of the project idea and would be involved throughout the project.

## Scope

The scope of the project is national but priority would be given to areas, which have been identified and water deficit and to farmers who grow fruits and vegetables.

## Activities

- Collection of agro-meteorological data
- Monitoring of water quality
- Establishment of water users groups
- Conduct feasibility study on the introduction of irrigation water and water users fee
- Study on the demand for irrigation (water demand and infrastructure). This study would include a baseline on existing irrigation systems
- Credit scheme
- Installation of micro-irrigation technologies
- Construction of micro-dams
- Conducting training programmes

## Timelines

The training and demonstration projects are planned to take place over a one-year period while the credit scheme is planned for a period of at least five years. This would allow for the demonstration projects to become operational and produce results, which would convince farmers to adopt the technologies.

## Budget/ Resource requirements/funding options

Training is required for farmers and other private professionals in the design and installation of irrigation infrastructure and agriculture pump

US\$1 million is the estimated budget for the credit scheme and grant funding. This amount is expected to provide access to funding for construction of irrigation infrastructure, solar irrigation pumps and technical assistance.

## Challenges

The main constraint the project could face is inadequate institutional support services from the ministry of agriculture due to limited staff. There is also the possibility of implementation delays due to the large number of climate change funded projects being implemented at the same time.

The project could also face a challenge with the lack of the commitment by farmers to activity, which is related to record keeping.

## Responsibilities and coordination

The Ministry of Agriculture would be responsible for the implementation of the project in collaboration with the Economic and Technical Cooperation Department.

## CHAPTER 2 TECHNOLOGY ACTION PLAN AND PROJECT IDEAS FOR DOMESTIC WATER SUPPLY SECTOR

### 2.1 Sector Overview

The National Water and Sewerage Act has been delegated full responsibility for the water supply for Grenada. NAWASA exploits 23 surface and six groundwater potable supply sources on the mainland, which yields some 54,600 m<sup>3</sup>/day (12mgd) in the rainy season and a maximum of 31,800 m<sup>3</sup>/day (10mgd) in the dry season. The water demand in the rainy season is 45,500 m<sup>3</sup>/day (10 mgd) and in the dry season, 54600 m<sup>3</sup>/day (12 mgd).

Grenada's water resources comprise primarily of surface water, with a groundwater potential to satisfy about 10%-15% of the present potable water requirement. Some communities, particularly, in the south of the island rely heavily on rainwater harvesting and storage to augment supplies during shortfalls mainly during the dry season. NAWASA allocates potable water to the various users based on the water requirements and availability; however, the tourism industry is given a high priority. Most of this water is abstracted from of rivers in high elevations Rainfall seasonality is marked and there is an estimated 30-40 percent drop in the available surface water during the dry season depending on the length and severity of this period. Scheduling of supply and trucking takes place during this period.

Grenada experiences extreme drought conditions during the dry season when the water demand increases mainly due to tourism and irrigation.

#### 2.1.1 Technology Description

Saltwater Reverse Osmosis is one of the methods used to desalinate seawater. Reverse osmosis not only reduces salt, but can also filter out metals, organic contaminants, and pathogens. Desalinated water is the only option to augment the sources of potable water supply in Grenada during prolonged dry periods. As the demand for freshwater increases and the amount of rainfall decreases because of climate variability and change Saltwater Reverse Osmosis has the potential to help Grenada adapt.

The initial capital investment for Saltwater Reverse Osmosis is very high; operational and maintenance costs are also very high, especially the energy costs.

There are mainly two environmental issues, which are associated with Saltwater Reverse Osmosis. They are the impact of the brine on the coastal environment and the impact of the saltwater intake on the marine life.

#### 2.1.2 Ambition for the TAP

A Saltwater Reverse Osmosis plant is to be installed in the south of Grenada to augment the water supply especially during the dry season and prolonged drought conditions.

### 2.1.3 Actions and Activities Selected for Inclusion in the TAP

The actions and activities for inclusion were selected from the measured identified to overcome the barriers to the diffusion of the technology. The barriers were identified using the Problem Tree methodology, while the measures were identified using the Solution Tree methodology. The actions and activities were prioritized for inclusion in the TAP.

#### Summary of barriers and measures to overcome barriers

Saltwater Reverse Osmosis		
Categories	Identified Barriers	Measures
Economic and financial	High capital cost High energy cost High cost of chemical High maintenance cost	Use of Solar PV as energy
Market Conditions	Technology not available on the local market	
Legal and regulatory	The water authority mandate does not include production of desalinated water	Revise mandate of local water authority
Network structures		
Institutional and organizational capacity	The National Water Policy does not include desalinated water NAP? Climate change policy? Tariff structure does not include desalinated water	Revise National Water Policy to include desalinated water Review tariff structure
Human skills	Limited capacity in desalination technology	Build capacity in Saltwater Reverse Osmosis
Social and cultural behavior	Negative perception of desalinated water quality among population in Grenada	Share information on quality of desalinated water produced in Carriacou
Information and awareness	Lack of awareness of use of desalinated among population in Grenada	Share information on usage of desalinated water produced in Carriacou
Technical		
Other	Limited sites for saltwater intake No feasibility studies No environmental and social impact studies	Conduct feasibility and social and environmental impact studies

**Actions selected for inclusion in the TAP**

Categories	Identified measures to overcome barriers	Measures selected as Actions for the TAP
Economic and Financial	Use of Solar PV as energy	Conduct feasibility study on use of Solar PV as energy
Market conditions		
Legal and regulatory	Revise mandate of local water authority	
Network structures		
Institutional and organisational	Revise National Water Policy to include desalinated water Review tariff structure	
Human skills	Build capacity in Saltwater Reverse Osmosis	
Social, cultural and behavioural	Conduct public awareness on desalinated water use	
Information and awareness	Conduct public awareness of desalination among population in Grenada	
Technical		
Other	Conduct feasibility and social and environmental impact studies	Conduct feasibility study Conduct Social and Environmental Impact Studies

**Activities selected for inclusion in the TAP**

<b>Action# 1</b>	<b>Conduct feasibility studies</b> to determine to determine plant size, brine disposal system, and power requirement
<b>Action# 2</b>	<b>Conduct of Social and Environmental Impact Studies</b>
<b>ACTIVITIES</b>	<b>Action 1</b>
<b>Activity 1.1</b>	Identify potential sites for saltwater intake
<b>Activity 1.2</b>	Procure consultancy services
<b>Activity 1.3</b>	Conduct feasibility studies
<b>Activity 1.4</b>	Review draft report
<b>Activity1.5</b>	Select site for saltwater intake
	Action 2
<b>Activity 2.1</b>	Procure consultancy services
<b>Activity 2.2</b>	Conduct Environmental and Social Impact studies
<b>Activity 2.3</b>	Review draft report
<b>Activity 2.4</b>	Hold public consultations

#### 1.2.4 Actions to be implemented as Project Ideas

The installation of a Saltwater Reverse Osmosis plant in Grenada will require preliminary research to identify potential sites for the location of the saltwater intake as well as the plant. An evaluation of the site of the previous plant and the saltwater intake would have to be conducted.

Research would also have to be conducted on other potential sites before a decision could be made on the location. An Environmental and Social Impact assessment would have to be done for every potential site before the saltwater intake and brine outfall could be selected.

A feasibility study has to be conducted on the size of the plant and the option for using Solar PV as energy.

The tariff structure would have to be reviewed because the cost of producing desalinated water is higher than surface water and the tariff structure is based on the cost of production of potable water using mostly surface water. There have been recommendations for a revised tariff structure to encourage demand reduction.

A revision of the National Water and Sewerage Authority (NAWASA) legislation and regulations would also be required. There would be a need for public education to prepare the public for the changes in the tariff structure as well the introduction of desalinated water.

## 2.1.5 Stakeholders and Timeline for Implementation of TAP

### Overview of Stakeholders for the implementation of the TAP

The National Water and Sewerage Authority is the primary stakeholder and would determine if the project is successful. The Environment Division is also an important stakeholder, because it can influence whether the project is successful. Since it is proposed that solar PV be used to power the desalination plant, Grenlec is a primary stakeholder. The local community selected for the site for the saltwater intake has to be involved from the beginning because they can oppose their construction of the feed water intake in their community and derail the project. The Ministry of Health, Environmental Health Department, Fisheries Department, and Physical Planning Unit are important stakeholders in the project because their approval would be required.

### Scheduling and Sequencing

The identification of the potential sites for the saltwater intake and brine outfall will be the first activities. The next activity will be the conduct of the Environmental and Social Impact Studies. These studies will provide the basis for selecting the saltwater intake and brine. The feasibility study would be the next activity.

### Scheduling and sequencing of specific activities

Action	Activities:	Planning		Implementation		Responsibility	
		Starting date	Ending date	Starting date	Ending date	Primary	Secondary
Conduct feasibility studies	Identify potential sites for saltwater intake					NAWASA	Physical planning
	Procure consultancy services					NAWASA	Department Economic Technical Cooperation
	Conduct feasibility studies					NAWASA	Physical Planning
	Review draft report					NAWASA	CCCCC
	Select site for saltwater intake					NAWASA	Physical Planning
Conduct Environmental and Social Impact studies	Procure consultancy services					NAWASA	Department Economic Technical Cooperation
	Conduct Environmental and Social Impact Studies					NAWASA	Physical Planning
	Review draft report					NAWASA	CCCCC
	Hold public consultations					NAWASA	Ministry of Health

## 2.1.6 Resources Needed for Action and Activities

Capacity requirements for implementation of activities are:

**Project management** skills are required to implement the activities for the project concept including procurement of consultancy services

**Financing:** skills are required to identify the funding source, which the project concept could be aligned with, and the coordinate with the relevant institutions to secure the funding

**Engineering:** non-engineering contract preparation skills are required for the preparation of the contract to conduct the feasibility study for the Salt Water Reverse Osmosis plant and the Environmental and Social Impact studies

Estimations of costs of actions and activities

Activities incurring costs include:

- Meetings
- Consultants to conduct feasibility and Environmental and Social Impact Studies  
(Based on the cost of the studies done in Carriacou it is estimated to cost US\$100,000)

## 2.1.7 Management Planning

### Risks and Contingency Planning

<b>Risk item</b>	<b>Description</b>	<b>Level of Risk</b>	<b>Mitigation/Contingency Action</b>
Scheduling	Consultants may take longer to complete the assignment	High	Allow for extra time in planning
Performance	Consultants selected may not deliver an acceptable quality of work	Medium	Ensure a very thorough evaluation of consultants proposals is done and Terms of Reference is well written

### 2.1.8 Next Steps

Immediate requirements	Designate project coordinator to follow to: Engage the Caribbean Community Climate Change Centre for technical assistance Engage the Grenada Electricity Company on plans to install Solar PV Saltwater Reverse Osmosis plant
Critical steps	Revise the Mandate of the National Water and Sewerage to include the provision of desalinated water

## 2.1.9 TAP overview table for Saltwater Reverse Osmosis technology

Sector	Water								
Subsector	Domestic Water Supply								
Technology	Saltwater Reverse Osmosis								
Ambition	To conduct the Benefit Cost Analysis and Environmental and Social Impact Studies for the installation of a Saltwater Reverse Osmosis Plant								
Benefits	Meeting the shortfall in potable water supply due to prolonged dry periods Protection of river from over abstraction and drying during prolonged dry periods Environmental flows in rivers are maintained and freshwater ecosystem conserved								
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for monitoring of implementation	Budget per activity	
Action 1 Conduct of feasibility study	Activity 1.1 Prepare Request for Proposals for consultancy	NAWAS A/CCCC	NAWASA	3 months		RFP advertised	Number of proposals received	0	
	Activity 1.2 Evaluation of proposals and selection of consultant	NAWAS A/CCCC	NAWASA	1 month		Proposals evaluated	Minutes of meeting to evaluate proposals	0	
	Activity 1.3 Award contract	NAWAS A	NAWASA	3 months		Contract awarded	Signed contract documents	-	
	Activity 1.4 Conduct feasibility study	Climate Change funds	NAWASA	6 months		Submission of	Inception report	5% of consultancy fees	
	Activity 1.5 Evaluation Feasibility study	NAWAS A/CCCC	NAWASA	1 month		Submission of reports	Draft report Final report	-	
	Activity 1.6 Identification of potential sites for salt water intake options	NAWAS A	NAWASA	3 months		Report on potential sites submitted	Report on options for saltwater intake		
Action 2 Conduct of Environmental and Social Impact Assessment of potential sites for saltwater intake	Activity 2.2 Award of contract for Environmental Impact Assessment (EIA) consultancy	NAWAS A	NAWASA	3 months		Contract documents finalised	Signed contract documents		
	Activity 2.3 Award of contract for Social Impact Assessment (ESIA)	NAWAS A	NAWASA	3 months		Contract documents finalised	Review of signed contract documents		
	Activity 2.4 Evaluation EIA and ESIA reports	NAWAS A/CCCC	NAWASA	1 month		Final reports submitted	Final reports Environmental Management Plan		
	Activity 2.5 Selection of site for saltwater intake	NAWAS A	NAWASA	3 months		Submission of inception report	Report on site selected		



## 2.2 PROJECT IDEAS FOR DOMESTIC WATER SUPPLY SECTOR

### 2.2.1 Brief Summary of the Project Ideas for Domestic Water Sector

Saltwater Reverse Osmosis technology is being proposed to augment the potable water supply especially for non-domestic customers in the south of the island especially during prolonged dry periods. This will require the revision of the legislative framework for water to include desalinated water. It will require preliminary activities such as the conduct of studies to anticipate the benefits and costs associated with the Saltwater Reverse Osmosis technology as well the environmental and social issues.

### 2.2.2 Specific Project Ideas

- Public awareness activities
- The use of Solar PV to power the Saltwater Reverse Osmosis plant
- The installation of Saltwater Reverse Osmosis plant
- Conduct feasibility study to determine plant size, brine disposal system, and power requirement
- Conduct Environmental and Social Impact study for the feed water intake and outfall for brine disposal
- Revision of National Water and Sewerage mandate to include desalinated water
- Review of water tariff structure
- Conduct public awareness
- Activities identified for implementation of selected actions
- Prepare Request for Proposals for consultancy
- Evaluation of proposals and selection of consultant
- Award contract
- Conduct Benefit/Cost Analysis
- Identification of potential sites for feed water intake options
- Award of contract for Environmental Impact Assessment (EIA)
- Award of contract for Social Impact Assessment (ESIA)
- Selection of site for saltwater intake
- Award of consultancy
- Conduct feasibility study
- Evaluation of feasibility study
- Drafting of environmental management plan
- Public consultations
- Install Salt Water Reverse Osmosis plant

#### Actions to be implemented as Project Ideas

- Feasibility study for the installation of a Salt Water Reverse Osmosis plant to produce desalinated water to augment the surface and ground water supplies.
- Environmental and Social Impact study for the saltwater intake and the outfall for brine disposal system are preliminary requirements to determine the feasibility of the investment in the Saltwater Reverse Osmosis technology.

- The installation of a Saltwater Reverse Osmosis plant powered by PV Solar in the south of Grenada

#### Introduction/Background

Grenada is reliant on surface water and ground water to a lesser extent as its potable water sources. Both sources are vulnerable to climate variability and change. The project is intended to help Grenada adapt to the projected changes in rainfall patterns. The projection is for the Caribbean to experience longer dry periods.

#### Objectives

To provide a source of potable water that is not climate dependent to augment depleting freshwater resources.

#### Output

- Public awareness programme
- Saltwater Reverse Osmosis plant

#### Relationship with sustainable development priorities

The technology is consistent with the Sustainable Development Goals (SDG) and the National Adaptation Plan 2017-2021.

#### Deliverables /Value/Benefits/Messages

The Saltwater Reverse Osmosis plant would provide water for the south of the island, which is the driest part of the island during prolonged dry periods. The desalinated water would augment the surface water and reduce on the amount of water abstracted from rivers causing them to dry out.

#### Scope

One Saltwater Reverse Osmosis plant would be installed in the island.

#### Activities

- Develop preliminary designs
- Identify manufacturers
- Finalize system design
- Draft design plans
- Perform economic analysis
- Identify land for location of Saltwater Reverse Osmosis
- Arrangement for solar power
- Confirm site for seawater intake
- Seawater outfall
- Determine power requirement
- Determine capacity of plant
- Installation of Saltwater Reverse Osmosis
- Conduct public awareness

## Timelines

Based on the experience of the Saltwater Reverse Osmosis technology installation in Carriacou and Petit Martinique the entire process from studies to completion of the Saltwater Reverse Osmosis is anticipated to take approximately 5 years. This is taking into the consideration that there may be a lapse between completion of the studies and the design and installation of the plant.

## Budget/ Resource requirements/funding options

Based on cost from the construction of the SWRO for Carriacou the estimated cost is 3 million US.

## Challenges

The main challenge to Saltwater Reverse Osmosis technology in the south of the island is the limited places available for location of the saltwater intake. Most of the coastal area is now developed.

## Responsibilities and coordination

The National Water and Sewerage Authority would be the lead agency on this project. NAWASA would also be responsible for coordinating the project activities.

## CHAPTER 3 TECHNOLOGY ACTION PLAN AND PROJECT IDEAS FOR TOURISM SECTOR

### 3.1 Tourism Sub-sector Overview

Grenada has a largely tourism-based, small economy. Over the past two decades, the economy has shifted from one of agriculture-dominant in that of services dominant with tourism serving as the leading foreign currency-earning sector. The tourism sector has seen substantial increases in foreign direct investment.

The tourism sector consists of a variety of sub-sectors including accommodation and yatching and cruise tourism. Grenada's accommodation range from budget guesthouses and self-catering apartments to luxury hotels and state of the art villas. The vast majority are locally owned and managed and located on the southwestern tip of the island.

#### **Relevant guidance documents for the tourism sector**

Name of legislation/regulation policy	Date enacted or revised	Main contents	
Grenada Master Plan for Tourism		<p>Impact of Tourism on the natural resource base. Natural resource base susceptible to tourism impact on freshwater and coastal and marine resources</p> <p>Beach resort tourism impacted most heavily on the environment through freshwater consumption. Freshwater consumption by stay over visitors in hotel can aggravate an already water shortage problem.</p> <p>Sewage disposal from hotels operating defective sewage packaged plants can pollute coastal waters.</p> <p>Recommendation: Changes to the level of legal and institutional framework</p> <p>Develop and codify pollution control standards for effluent discharge.</p> <p>Development of onsite near natural sewage treatment.</p> <p>Use the final water emanating from onsite system for landscape irrigation so as to relieve the pressure on domestic water supply.</p>	

Grenada Tourism Authority Strategic Plan 2015-2018	December 2014		
Policy Framework for Tourism in Grenada, Carriacou and Petit Martinique	2011	One of the objective is the protection and conservation of the country's natural resources	

### 3.1.1. Wastewater Technology Description

Wastewater treatment technologies are varied and allow treatment that is fit for purpose. In this case the technology under consideration is for reuse of wastewater for landscape irrigation.

Some local hotels with onsite wastewater treatment systems are currently operating the Sequencing Batch Reactor (SBR) (Cromaglass). The SBR does not provide for disinfection but its also very cost effective if treatment beyond biological treatment is required.

The chlorine contact tank can be used to disinfect the wastewater produced by the SBR and it could be reused for landscape irrigation. The reuse of the wastewater would result in savings on water utility bills and reduction in the use of potable water for landscape irrigation.

The treatment of the wastewater would reduce pressure on the freshwater resources and lead to an improvement in the coastal ecosystems since most of the hotels are located on the coast.

### 3.1.2 Ambition for the TAP

Hotels with existing with Sequencing Batch Reactor wastewater technology would be upgraded to disinfection. It is also intended to strengthen the legislative framework and develop a policy and an institutional framework for the treatment and reuse of wastewater. It is also intended to build capacity in surveillance, enforcement and manpower.

### 3.1.3 Actions and Activities Selected for Inclusion in the TAP

The actions and activities for inclusion were selected from the measured identified to overcome the barriers to the diffusion of the technology. The barriers were identified using the Problem Tree methodology, while the measures were identified using the Solution Tree methodology. The actions and activities were prioritized for inclusion in the TAP.

#### Summary of barriers and measures to overcome barriers

Wastewater Treatment and Reuse technology		
Categories	Identified Barriers	Measures
Economic and financial	High investment cost	Incentive credit scheme (loan/grant)
Market Conditions	Mechanical plants not sold locally	
Legal and regulatory	Outdated legislation Lack of standards for effluent discharge Absence of a National Sanitation Policy Lack of institutional framework for wastewater treatment and reuse National Water Policy does not include wastewater reclamation and reuse	Revision of legislation and drafting of regulations including Section 17 of the Tourist Board Act Draft standards for effluent discharge Develop institutional framework for wastewater reclamation and reuse Revise National Water Policy to include wastewater reclamation and reuse
Network structures		
Institutional and organizational capacity	Frequent shuffling of ministerial responsibility for environment management among various ministries Lack of interagency coordination and a legislative base for the enforcement of regulations	Draft National Sanitation Policy
Human skills	Low technical capacity	Capacity building for staff of the Environmental Health Department and the Environment Department
Social and cultural behavior	Negative perception of reclaimed water	Public consultation on wastewater treatment and reuse for key stakeholders
Information and awareness	Lack of awareness of wastewater reclamation and reuse technology	Sensitization workshop on wastewater treatment and reuse technologies

Technical	Existing technology does not meet standard required	Modification of technology to meet required standard
Other		

### 3.1 4 Actions to be Implemented as Project Ideas

Categories	Identified measures to overcome barriers	Measures selected as Actions for the TAP
Economic and Financial	Incentive credit scheme (loan/grant)	Incentive scheme (loan/grant)
Market conditions		
Legal and regulatory	Revision of legislation and drafting of regulations including Section 17 of the Tourist Board Act Draft standards for effluent discharge	
Network structures		
Institutional and organisational	Draft National Sanitation Policy	
Human skills	Capacity building for staff of the Environmental Health Department and the Environment Department	Capacity building
Social, cultural and behavioral	Public consultation on wastewater treatment and reuse for key stakeholders	
Information and awareness	Sensitization workshop on wastewater treatment and reuse technologies	
Technical	Modification of technology to meet required standard	Construct chlorination contact tanks
Other		

### Activities identified for implementation of selected action

<b>Action# 1</b>	<b>Establishment of incentive scheme</b> comprises percentage loan and percentage grant upgrade of hotel wastewater treatment plants to disinfection level for reuse as landscape irrigation water
<b>Action# 2</b>	<b>Capacity building</b> in wastewater treatment and reuse monitoring, and enforcement and operation of wastewater treatment plants
<b>Action# 3</b>	<b>Construction of chlorination contact tanks/UV treatment system</b> to treat wastewater in hotels to disinfection standard to be reused for landscape irrigation
<b>ACTIVITIES</b>	<b>Action 1 Establishment of incentive scheme</b>
<b>Activity 1.1</b>	Hold workshop with key stakeholders to discuss the incentive scheme
<b>Activity 1.2</b>	Procure consultancy services for design the incentive scheme
<b>Activity 1.3</b>	Design draft incentive programme
<b>Activity 1.4</b>	Finalise incentive programme
	<b>Action 2 Capacity building</b>
<b>Activity 2.1</b>	Collaborate with the University of Technology Jamaica Wastewater Management programme and regional institutions
<b>Activity 2.2</b>	Identify participants with suitable qualifications to attend the course for plant operator/regulators
<b>Activity 2.3</b>	Secure places in regional course wastewater management for plant operators/regulators
<b>Activity 2.4</b>	Finalize arrangement for course attendance
	<b>Action 3 Construction of chlorination contact tanks</b>
<b>Activity 3.1</b>	Meet with hoteliers with onsite wastewater treatment systems
<b>Activity 3.2</b>	Procure consultancy services for the design of the chlorination contact tank
<b>Activity 3.3</b>	Prepare preliminary designs
<b>Activity 3.4</b>	Finalise designs
<b>Activity 3.5</b>	Construct chlorination contact chamber/UV treatment system

### 3.1.5 Stakeholders and Timeline for implementation of TAP

#### Overview of Stakeholders for the implementation of the TAP

Any project involving the hotel industry should have the Grenada Hotel and Tourism Association as a key stakeholder. The association would be key in institutionalizing the environment management system in the hotels and the subsequent certification.

The other very important key stakeholder would be Environment Department because that department would be responsible for setting the specific technology standards for wastewater treatment installation.

The Ministry of Tourism is a an important stakeholder and would be expected to work closely with the Grenada Hotel and Tourism Association.

The Economic Cooperation Department Ministry of Finance is the department responsible for mobilizing resources for projects and would be therefore influence whether the resources are mobilized for the project.

The Grenada Hotel and Tourism Association would be key in promoting the wastewater treatment and reuse as part of the process of obtaining certification for the hotels.

The project could benefit from the experience of the Caribbean Community Climate Change Centre, which implemented a similar project at a the Coconut Bay Resort and Spa in St Lucia.

The Environmental Health and Sustainable Development Department of the Caribbean Public Health Agency is a key stakeholder in the process. The department is promoting the reuse of wastewater and could provide technical assistance.

### Scheduling and sequencing of specific activities

Action	Activities:	Planning		Implementation		Responsibility	
		Starting date	Ending date	Starting date	Ending date	Primary	Secondary
<b>Establishment of incentive scheme</b>	Hold workshop with key stakeholders to discuss the incentive scheme					Department Economic Technical Cooperation	Hotel & Tourism Association/ Ministry Tourism
	Procure consultancy services for design the incentive scheme					Department Economic Technical Cooperation	Hotel & Tourism Association/ Ministry Tourism
	Design draft incentive programme					Department Economic Technical Cooperation	Hotel & Tourism Association/ Ministry Tourism
	Finalise incentive programme					Department Economic Technical Cooperation	Hotel & Tourism Association/ Ministry Tourism
<b>Capacity building</b>	Collaborate with the University of Technology Jamaica Wastewater Management programme and regional institutions	9/2018				Environmental Health Department/ NAWASA	Department Economic Technical Cooperation
	Identify participants with suitable qualifications to attend the course for plant operator/regulators					Environmental Health Department/ NAWASA	Department Economic Technical Cooperation
	Secure places in regional course wastewater management for plant operators/regulators					Environmental Health Department/ NAWASA	Department Economic Technical Cooperation
	Finalize arrangement for course attendance					Environmental Health Department/ NAWASA	Department Economic Technical Cooperation
<b>Construction of chlorination contact tanks/UV Treatment System</b>	Meet with hoteliers with onsite wastewater treatment systems					Hotel & Tourism Association/ Ministry Tourism	Department Economic Technical Cooperation/ Environmental Health
	Procure consultancy services for the design of the chlorination contact tank					Department Economic Technical Cooperation/ Environmental Health	Hotel & Tourism Association/ Ministry Tourism
	Prepare preliminary designs					Environmental Health	Hotel & Tourism Association/ Ministry Tourism
	Finalise designs					Environmental Health	Hotel & Tourism Association/

							Ministry Tourism
	Construct chlorination contact chamber/UV treatment system					Environment al Health	Hotel & Tourism Association/ Ministry Tourism

### 3.1.6 Estimation of Resources Needed for Action and Activities

Capacity requirements for implementation of activities are:

**Financial planning** skills are required to design the loan/grant credit scheme.

**Project management** skills are required to implement the activities for the project concept including preparation of contracts and procurement material for the chlorine contact tank or UV treatment system. Skills are also required to coordinate with the regional agencies organising the regional course for wastewater plant operators and regulators at the University of Technology Jamaica, to secure places for Grenada.

**Financing:** skills are required to identify the funding source, which the project concept could be aligned with, and the coordinate with the relevant institutions to secure the funding

**Engineering:** skills are required for the design of the chlorine contact tanks or installation of the UV treatment system.

**Technology deployment:** skills are required for the installation of the UV treatment system and construction of chlorination contact tank

Estimations of costs of actions and activities

Activities incurring costs include:

- Meetings
- Wastewater Training course for Plant Operators and Regulators (travel, accommodation, allowances per person, cost of course is Plant Operators US\$1500 per person, Regulators
- Consultants to design the chlorine contact tanks
- Construction of chlorine contact tanks

### 3.1.7 Management Planning

#### **Risks and Contingency Planning**

<b>Risk item</b>	<b>Description</b>	<b>Level of Risk</b>	<b>Mitigation/Contingency Action</b>
Cost	The cost of the construction of the chlorine contact tank and UV treatment could be higher than estimated because of changes in the prices	Medium	Include contingency item in budget line
Scheduling	The construction of Chlorine contact tank could take longer due to delays caused by weather etc.		Allow extra time in the planning process
Performance	The technology may not perform as expected		The risk performance is to be included in the contract and tied to payment

### 3.1.8 Next Steps

Immediate requirements	Assign a coordinator to: Follow up with the University of Technology and regional institutions to secure places for participants from Grenada To coordinate activities with the Environment Health Department, Ministry of Tourism, the Grenada Hotel and Tourism, NAWASA and the Department of Economic and Technical Cooperation
Critical steps	Drafting of the relevant effluent discharge standards for wastewater from hotels Revision of Public Health Act and the building requirements, which will make it mandatory for new hotels with wastewater treatment systems to reuse the waste water for landscape irrigation.

### 3.1.9 TAP Overview Table for Wastewater Treatment and Reuse Technology

Sector	Water							
Subsector	Tourism							
Technology	Wastewater Treatment and Reuse							
Ambition	To upgrade hotels onsite waste water treatment system to disinfection level for reuse in landscape irrigation and to develop a monitoring and enforcement, institutional framework							
Benefits	Reclaimed wastewater reused for landscape irrigation Savings in water utility bills for the hotels Opportunity for hotel to become industry certified Protection of coastal ecosystem Create employment for plant operators							
Action	Activities to be implemented	Sources of funding	Responsible body and focal point	Time frame	Risks	Success criteria	Indicators for monitoring of implementation	Budget per activity
Action 1 Creation of a incentive programme for hotels with onsite waste water treatment systems	Activity 1.1 Design of incentive programme	Government of Grenada	Department of Economic and Technical Cooperation/ Grenada Hotel and Tourism Association	6 months		Finalised incentive programme	Incentive programme documents	0
Action 2 Provide scholarship opportunities for persons in operations of waste water treatment plants	Activity 2.1 Confirmation of cost for course	Government of Grenada	Department of Economic & Technical Cooperation	1 month		Information cost for course	Final cost of course for participants	0
	Activity 2.2 Confirmation of number of suitable applicants for course	Government of Grenada	Department of Economic & Technical Cooperation	1 months		Applicants list	Final list of applicants	0
	Activity 2.3 Selection of participants for course	Government of Grenada	Department of Economic & Technical Cooperation	6 months		List of awardees	List of awardees	0
	Activity 2.4 Finalise arrangements for participation in courses	Climate Change funds	Department of Economic & Technical Cooperation/Environmental Health /NAWASA	9 months		Awardees informed of selection	Letter of award	
	Activity 2.5 Awardees attend training course	Regional funds	Department of Economic & Technical Cooperation/Environmental Health /NAWASA	2-3 weeks		Confirmation of course attendance	List of certified participants	
Action 3 Design and construction of	Activity 3.1 Select and hire consultant	Climate Change funds	Hotel and Tourism Association	3 months		Contract documents prepared	Signed contract documents	
	Activity 3.2 Conduct an assessment of the status	Climate Change funds	Department of Economic & Cooperation and Hotel and	1 week		Inception report submitted	Final report	

chlorination contact tanks/UV treatment system	wastewater treatment at hotels with SBRs		Tourism Association/Environmental Health					
	Activity 3.3 Design upgrade and prepare drawings for chlorination tanks/UV treatment system	Climate Change funds	Hotel and Tourism Association/Environmental Health	3 months		Preliminary drawings submitted	Final drawings	
	Activity 3.4 Submit drawings for approval	Government of Grenada	Hotel and Tourism Association/Environmental Health	3 months		Drawings submitted or approval	Approved drawings	0
	Activity 3.5 Request cost estimates for construction of chlorination tank	Climate Change funds	Hotel and Tourism Association	3 months		Receipt of quotations	Number of quotations received	
	Activity 3.6 Award contract for construction of tank and construction	Climate Change funds	Hotel and Tourism Association	1 month		Contract documents finalised	Signed contract	

## 3.2 PROJECT IDEAS FOR TOURISM SECTOR

### 3.2.1 Brief summary of the Project Ideas for Wastewater Reuse

The project would develop an institutional and legal framework for wastewater treatment and reuse for Grenada Carriacou and Petit Martinique. It would also provide a cadre of trained professionals who would be able to regulate wastewater treatment and reuse and trained plant operators. It would support the upgrade of hotels with existing wastewater treatment system to disinfection and reuse of the wastewater for landscape irrigation.

### 3.2.2 Specific project ideas

- Revision of legislation and drafting of regulations including Section 17 of the Tourist Board Act
- Capacity building for staff of the Environmental Health Department of the Ministry of Health and plant operators
- Training for hotel staff in Environmental Management Systems including wastewater reuse
- Public awareness programme for key stakeholders to foster an understanding within Grenada of the importance of environmental protection and pollution control and the conservation of natural resources
- Framework for concessions to include wastewater treatment investment incentives for hotel industry to invest in wastewater reclamation and reuse technology by linking it to support for industry certification
- Develop technical guidance documents for wastewater treatment and reuse technology
- Invest in a cost sharing activity, which would demonstrate the benefits of the investment
- Develop standards for effluent discharge for the Grenada
- Revised National Water Policy to include the reuse of wastewater

#### Actions to be implemented as Project Ideas

Two actions would be implemented as project ideas. The first the building of manpower capacity to monitor and enforce legislation on the operations wastewater treatment plants for reuse. The second is the creation of a part loan part grant incentive programme for hotels with onsite wastewater treatment systems to upgrade to tertiary level.

#### Objectives

- To treat wastewater to a standard where it could be reused.
- To develop an institutional framework for the surveillance of wastewater for Grenada
- To provide training for persons involved in the regulation and operation of wastewater systems
- To provide with the opportunity for hotels to obtain green certification

#### Outputs

- Revised legislation
- Institutional framework for wastewater management

- Professionals trained in wastewater treatment
- Revised building regulations requiring new hotels would not be connected to the central wastewater network to install onsite wastewater treatment systems to reuse wastewater for landscape irrigation.
- Regulators and plant operators in Grenada trained in wastewater treatment and reuse technology
- Standards for effluent discharge

#### Relationship with sustainable development priorities

The project is consistent with the Sustainable Development Goal (SDG6). It is also one of the strategies in the National Adaption Plan 2017-2021.

#### Deliverables Value/Benefits/Messages

- Reduction in environmental pollution
- Reduction use of potable water for non-potable purposes so more water available for potable purposes
- Reduction in river abstraction for potable purposes
- Wastewater treatment systems that produce water that could be reused for non-potable purposes

#### Scope

The institutional framework and revised legislative framework would be implemented at the national level. The capacity developed would serve the entire country. The standards and guidelines to be developed for wastewater reuse in the accommodation sector would also be applicable to the entire country.

#### Activities

- Training for hotel staff in Environmental Management Systems including wastewater reuse
- Create awareness among key stakeholders to foster an understanding within Grenada of the importance of environmental protection and pollution control and the conservation of natural resources
- Framework for concessions to include wastewater treatment investment incentives for hotel industry to invest in wastewater reclamation and reuse technology by linking it to support for industry certification
- Develop technical guidance documents for wastewater treatment and reuse technology
- Invest in a cost sharing activity, which would demonstrate the benefits of the investment
- Include standards for effluent discharge for the Grenada

#### Timelines

This project would be implemented over a 5-year period.

#### Budget/ Resource requirements/funding options

The resources required for the infrastructure would be site specific. There would be a need for engineering and non-engineering services. The project is expected to receive financial support from the G-CREWS project and regional organisations.

### Challenges

The main challenge would be convince the hoteliers to make use of the loan/grant facility to invest of the technology.

### Responsibilities and coordination

The Grenada Hotel and Tourism Association would be responsible for implementing the project with the support of the Ministry of Tourism and the Environmental Health Department of the Ministry of Health. The Economic and Technical Cooperation Department of the Ministry of Finance would be responsible for approving support for the loan/grant programme.